Early Pennsylvanian Ammonoids from Southern Nevada

GEOLOGICAL SURVEY PROFESSIONAL PAPER 613-C

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By MACKENZIE GORDON, JR.

CONTRIBUTIONS TO PALEONTOLOGY

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Four species of late Morrow age characterize the Diaboloceras peroccidens *Zone at the base of the Pennsylvanian sequence in Clark and Nye Counties*

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EARLY PENNSYLVANIAN AMMONOIDS FROM SOUTHERN NEVADA

By MACKENZIE GORDON, JR.

ABSTRACT

Five species of ammonoids of late Morrow age are described from the basal part of the Pennsylvanian sequence in the foothills of the Spring Mountains, northern Clark County, and at the Nevada Test Site, southern Nye County, Nev. Deposits of very late Mississippian and early Morrow age are absent in this region, where an unconformity is present between Upper Mississippian and Lower Pennsylvanian rocks. Species described are *Syngastrioceras lanei* n. sp., *S. oblatum* (Miller and Moore), *Bisatoceras nevadense* n. sp., *Diaboloceras peroccidens* n. sp., and *Stenopronorites* sp. Four of these species (the occurrence of *Syngastrioceras oblatum* being an isolated one) characterize the *Diaboloceras peroccidens* Zone, of middle late Morrow age. This fauna correlates with that of the middle part of the Bloyd Shale in the type section of the Morrow Series in northwestern Arkansas.

INTRODUCTION

Pennsylvanian ammonoids have been, until recently, virtually unknown in the far western United States. The discovery of a cephalopod fauna of late Morrow age in Clark and Nye Counties, Nev., was announced by Gordon and Poole in 1966. Previously, Poole, Orkild, Gordon, and Duncan (1965, p. A52) briefly noted a fauna indicative of an Early Pennsylvanian age from the Nevada Test Site.

The first of these ammonoids from southern Nevada was a worn specimen of *Syngastrioceras oblatum* (Miller and Moore). It was found in a small collection of fossils made by C. R. Longwell in 1952 from the lower part of the Bird Spring Formation in Lucky Strike Wash, Spring Mountains, near Las Vegas. In the spring of 1957, Longwell and I examined this section but were unable to find the bed from which the ammonoid came nor did we discover any additional specimens.

A second find of Pennsylvanian ammonoids in southern Nevada came in 1961; P. P. Orkild, who was mapping the Tippipah Spring quadrangle in the Nevada Test Site near Mercury, sent me crushed specimens of a schistoceratid resembling *Brannero-ceras*. Later that same year, Helen Duncan, F. G. Poole, Orkild, and I collected further specimens at the Nevada Test Site from Orkild's Red Canyon section and found additional ammonoids, including *Bisatoceras*, in the C. P. Hills. This resulted in the brief citation of this fauna in a paper (Poole and others, 1965, p. A52) on the age of the Eleana Formation. In 1964, F. A. McKeown's field mapping in the Yucca Lake quadrangle in the Nevada Test Site provided an additional young specimen, cited as *Boesites?* in Poole, Orkild, Gordon, and Duncan (1965, p. A52), but now regarded as a young *Steno-pronorites*.

In the fall of 1965, further studies in southern Nevada by Poole and me permitted recognition of this ammonoid assemblage over a wider area. The same fauna was found in Clark County at the north end of the Spring Mountains, a few miles west of Indian Springs. In the spring of 1966, N. Gary Lane provided additional material, which he had collected earlier that year at a locality just south of Indian Springs. Lane's material demonstrates that the schistoceratid in this fauna is a primitive *Diaboloceras*.

ACKNOWLEDGMENTS

I would like to thank Prof. N. Gary Lane, University of California at Los Angeles, and Prof. G. D. Webster, San Diego State College, for their kindness in making their collection of Early Pennsylvanian ammonoids from the locality near Indian Springs available for study and deposit in the U.S. National Museum.

AMMONOID LOCALITIES

The ammonoids come from nine collections made at five localities (fig. 1). Descriptions of the localities at which each collection was made are given in the locality register that follows figure 1 and the list of ammonoid fauna.

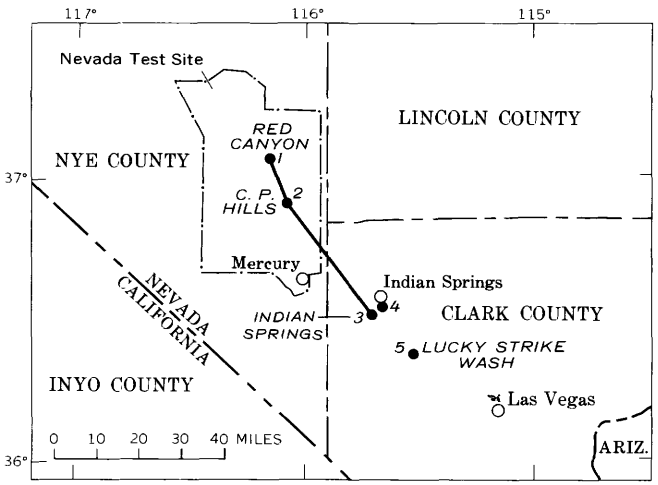


FIGURE 1.—Lower Pennsylvanian ammonoid collecting localities in southern Nevada.

Locality in fig. 1	1			2			3	4	5
USGS locality no.	19668–PC	20559–PC	22435–PC	20562–PC	22071–PC	22442–PC	22465–PC	23300–PC	16315–PC
Syngastrioceras lanei n. sp							X	X	
S. oblatum (Miller and Moore)									X
Bisatoceras nevadense n. sp				X		X	X	X	
Diaboloceras peroccidens n. sp	X	X	X			X	X	X	
Stenopronorites sp					X		X	X	

Locality register

USGS Locality No.	Locality in fig. 1	Description and collectors
16315–PC	5	Charleston Peak 15-min quadrangle, Nev. Northwest of Lucky Strike Wash, 8 miles south of Tonopah Highway in SW¼ sec. 30, T. 18 S., R. 58 E., Spring Mountains, Clark County, Nev. Bird Spring Formation, basal unit, within 75 ft. of base. Collector, C. R. Longwell, Aug. 4, 1952.
19668–PC	1	Tippipah Spring 7½-min quadrangle, Nev. Red Canyon, north side of Red Canyon drainage, Nevada Test Site, Nye County, Nev. [same as USGS locs. 20559–PC and 22435–PC]. Tippipah Limestone, lower 200 ft. Collector, P. P. Orkild, May 1960.
20559–PC	1	Tippipah Spring 7½-min quadrangle, Nev. Red Canyon section, in northwest part of northern outlier of Syncline Ridge, on west slope and in southwest-trending drainage of the more western and lesser of two summits of hill 5203, about 1,700 ft due west of 5203 summit (exactly 4 miles airline northeast of Tippipah Spring water tanks), Nevada Test Site, Nye County, Nev. Tippipah Limestone, fossils from a 30-ft zone whose base is 30 ft above base of formation. Collectors, Mackenzie Gordon, F. G. Poole, P. P. Orkild, Helen Duncan, R. A. Lewandowski, and R. D. Rieke, Aug. 16, 1962.
20562–PC	2	Yucca Lake 7½-min quadrangle, Nev. From window exposing Carboniferous formations beneath thrust plate in C. P. Hills, 2¼ miles southwest of Yucca Pass in Area 6 of Nevada Test Site, on east slope of hill whose summit slightly exceeds 4,700 ft in elevation, Nye County, Nev. Lat 36°54′48″ N.; long 116°04′58″ W. Tippipah Limestone, ammonoids from basal 2 ft. Collectors, Gordon, Poole, and others, Aug 17, 1962.
22071–PC	2	Yucca Lake 7½-min quadrangle, Nev. On east slope of C. P. Hills near head of main access wash, in window of Carboniferous rocks just below C. P. thrust. Lat 36°55′11″ N.; long 116°05′12″ W., Nevada Test Site, Nye County, Nev. Tippipah Limestone, lower 20 ft. Collector, F. A. McKeown, 1964.
22435–PC	1	Tippipah Spring 7½-min quadrangle, Nev. Same locality as 20559–PC and extending as far north as saddle on west slope of hill. Tippipah Limestone, lower 60 ft. Collectors, Gordon, Orkild, Poole, and J. W. Miller, Sept. 14, 1965.
22442–PC	2	Yucca Lake 7½-min quadrangle, Nev. Same locality as 20562–PC, within 100 ft north along contact. Tippipah Limestone, basal 2 ft. Collectors, Gordon, Poole, and Miller, Sept. 16, 1965.
22465–PC	3	Las Vegas 2° sheet, Nev. Indian Springs area. Fossiliferous beds exposed in shallow saddle at head of southwest-trending wash, 4½ miles southwest of Indian Springs, probably in NW¼ sec. 31, T. 16 S., R. 56 E. (unsurveyed), Clark County, Nev. Bird Spring Formation, 1 to 3 ft above base, Collectors, Gordon, Poole, and Miller, Sept. 19, 1965.
23300–PC	4	Las Vegas 2° sheet, Nev. Indian Springs area. Limestone bed exposed in bulldozer cut across Indian Springs-Bird Spring contact at east end of hill exposing Bird Spring Formation, about 2 miles south and slightly east of Indian Springs, Clark County, Nev. Bird Spring Formation, 1 to 3 ft above base. Collectors, N. G. Lane and G. D. Webster, 1966.

STRATIGRAPHIC SETTING

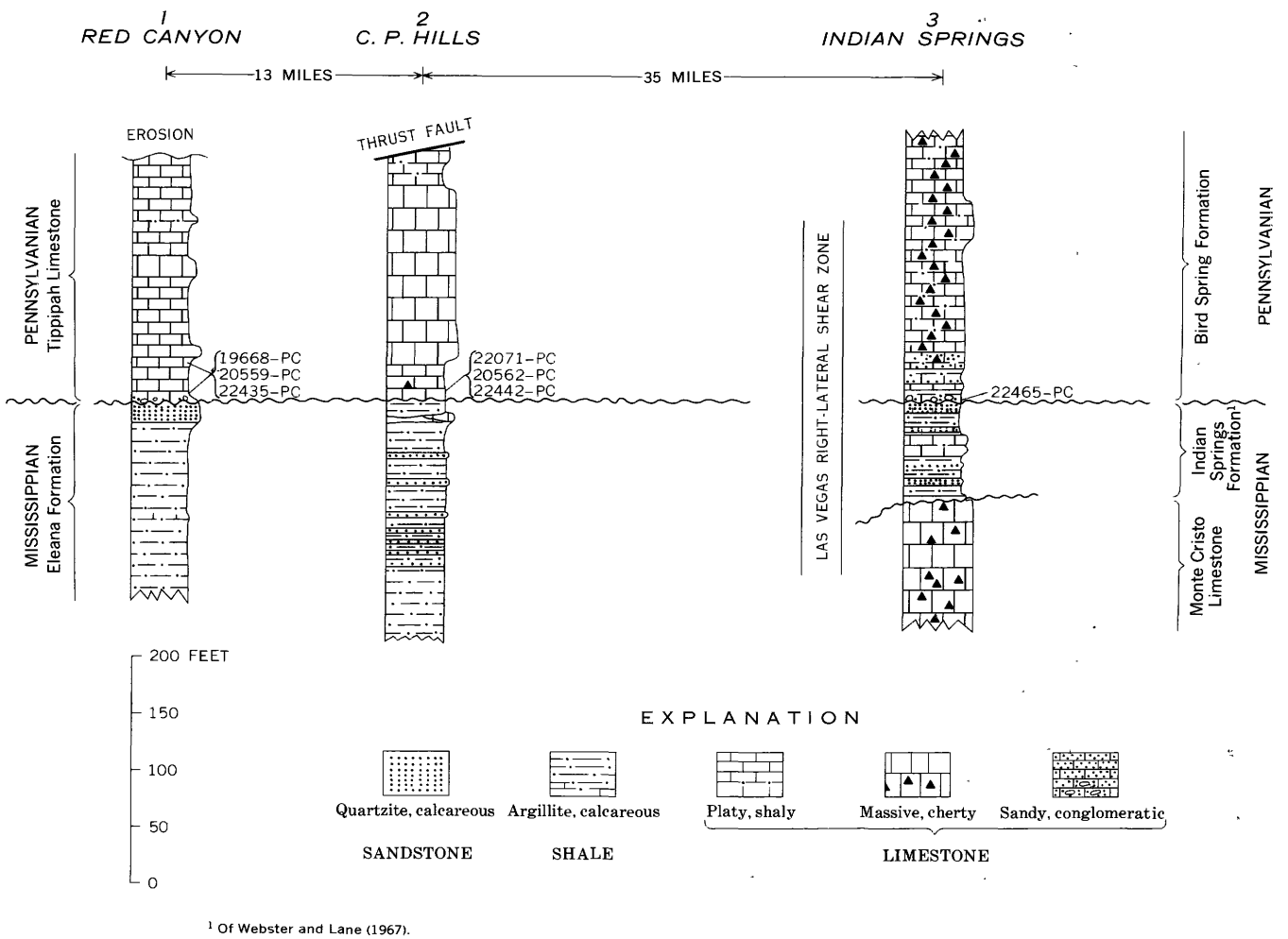
Columnar sections for localities 1–3 (fig. 1) are shown in figure 2. It will be noted that the stratigraphic terminology for the Nevada Test Site (locs. 1 and 2), Nye County, is different from that employed in Clark County on the south side of the Las Vegas lateral shear zone.

The Upper Mississippian-Lower Pennsylvanian section in the Nevada Test Site is relatively simple. The Eleana Formation, Late Devonian to Late Mississippian in age, composed predominantly of shale with interbedded coarser clastic rocks, is overlain by the Tippipah Limestone, of Early Pennsylvanian age, which consists of intercalated massive and very thin bedded limestone. The upper part of the Eleana is composed of brown-weathering shale with some relatively thin intercalated sandstone and limestone beds and resembles the equivalent part of the Chainman Shale, farther northeast in the Great Basin.

Stratigraphically about 100 feet below the Mississippian-Pennsylvanian unconformity in the Red Canyon section (loc. 1, fig. 1), ammonoids of the *Cravenoceras merriami* zone of late Chester age have been found (Gordon and Poole, 1966). Ammonoids of the family Schistoceratidae occur throughout the lower 140 feet of the Tippipah Limestone in the Red Canyon section. Although *Diabloceras peroccidens* n. sp. is the only ammonoid known at this locality, all specimens cannot be definitely assigned to this species because none have sutures preserved.

In the section in the C. P. Hills, the Pennsylvanian ammonoids are restricted to the basal part of the Tippipah Limestone; they all probably come from the basal 2–3 feet of the formation.

In the Indian Springs region at the north end of the Spring Mountains, much of the section equivalent in age to the Eleana Formation is represented by a predominantly limestone sequence, the Monte



[1] Of Webster and Lane (1967).

FIGURE 2.—Columnar sections for ammonoid collecting localities 1–3, figure 1. Modified from Gordon and Poole (1968).

Cristo Limestone of Mississippian (Kinderhook to Meramec) age. It is overlain unconformably by a Chainman-like shale unit which Longwell and Dunbar (1936) included in their Indian Springs Member, the Bird Spring Formation. In figure 2, the Indian Springs Formation is used in the sense of Webster and Lane (1967, p. 507–510), is restricted to that part of Longwell and C. O. Dunbar's unit that lies below the Mississippian-Pennsylvanian unconformity, and is not included in the Bird Spring Formation.

The Bird Spring Formation, revised in this manner, begins at the same level as the Tippipah Limestone of the Nevada Test Site. The lithology of the two formations is similar, except that considerably more chert is present in the lower part of the Bird Spring Formation. A conglomerate about 1 foot thick marks the base of the Bird Spring Formation in the vicinity of Indian Springs and can be traced along the contact for several miles. The ammonoids occur immediately above this conglomerate through an approximately 2-foot zone of limestone that is locally an organic detritus.

In Lucky Strike Wash on the east side of the Spring Mountains (loc. 5, fig. 1), the Indian Springs Formation is absent, and the Bird Spring Formation rests unconformably on the Monte Cristo Limestone. The lower 50 feet of the Bird Spring Formation includes limestone beds crowded with poorly preserved coarsely silicified specimens of *Rhipidomella nevadensis* (Meek). The abundance of this brachiopod suggests a Late Mississippian age for the basal part of the Bird Spring Formation at this locality. Presumably the worn specimen of *Syngastrioceras oblatum* (Miller and Moore) came from a slightly higher level in the formation.

DIABOLOCERAS PEROCCIDENS ZONE

The four species found associated in the assemblage at the base of the Bird Spring Formation in northern Clark County and in the Tippipah Limestone in southern Nye County constitute the ammonoid assemblage that characterizes what I term the *Diaboloceras peroccidens* Zone. Whether the occurrence of *Syngastrioceras oblatum* (Miller and Moore) at Lucky Strike Wash should be referred to the same zone is not known at present. The *Diaboloceras peroccidens* assemblage has been found at localities as much as 48 miles apart. As these localities occur on both sides of the Las Vegas lateral shear zone and because displacement along this shear zone is believed to have approximated 30 miles (Gordon and Poole, 1966), the original distribution of this fauna was even greater than is now apparent.

The age of this zone can be determined with reasonable accuracy by fitting *Diaboloceras peroccidens* n. sp. into the evolutionary pattern of the schistoceratids, as it is presently known. This Nevada species is the most primitive *Diaboloceras* known. It represents the next step beyond *Brannerоceras branneri* (Smith), from the Brentwood Limestone Member at the base of the Bloyd Shale in northwestern Arkansas. The umbilical lobe of *B. branneri* has migrated onto the flanks to become a second lateral lobe in *D. peroccidens* n. sp. *Diaboloceras peroccidens* had not yet developed the tendency toward triangular coiling of the early whorls as in *D. neumeieri* Quinn and Carr from the Trace Creek Shale Member at the top of the Bloyd Shale in northeast Arkansas. Its stage of development places it in middle Bloyd time. Thus, the *Diaboloceras peroccidens* Zone would seem equivalent, at least in part, to the *Axinolobus modulus* zone of middle Bloyd age in northwest Arkansas, which occurs stratigraphically between the *Branneraceras branneri* and *Diaboloceras neumeieri* zones.

DESCRIPTIVE PALEONTOLOGY

Genus SYNGASTRIOCERAS Librovitch, 1938

Syngastrioceras lanei n. sp.

Figures 3*A–D*, 4*A–C*

Diagnosis.—*Syngastrioceras* with involute subglobose to globose conch. First lateral lobe of suture of moderate width.

Description.—Conch subglobose during much of growth, some individuals globose at diameters from 18 to 26 mm, none seen in excess of 30 mm; involute, diameter of umbilicus normally equal to a little less than one-third diameter of conch except during early growth when it is greater. Venter and flanks gently convex, strongest rounding along ventrolateral zones; umbilical shoulder subangular; umbilical wall gently convex. First two whorls coiling planorbitally, widening rapidly in later whorls.

Shell surface appears smooth but has very fine, somewhat unequal, closely-spaced growth lirae that are radial at umbilical shoulder, form a shallow broad sinus over each flank, bow forward at each ventrolateral zone and are nearly straight or almost imperceptibly indented into faint sinus over venter; overall effect is of flat orad bow across venter. In addition, four to five fairly broad shallow internal varices that roughly follow the configuration of transverse lirae occur on each whorl. Longitudinal

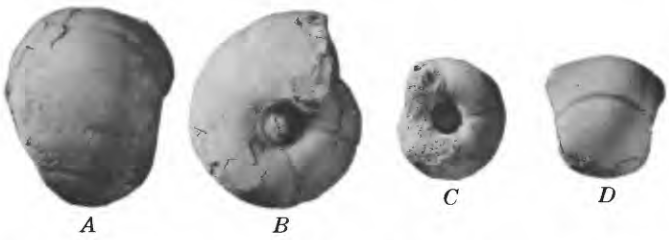


FIGURE 3.—*Syngastrioceras lanei* n. sp. *A*, *B*, Ventral and side views of holotype, USNM 161525, from USGS loc. 22465–PC; *C*, *D*, side and ventral views of paratype, USNM 161526, from same locality. All views × 1.

sculpture is limited to a fairly strong cord along each umbilical shoulder.

Suture has been observed only at diameters less 15 mm. At an estimated conch diameter of 10 mm (fig. 4*C*), suture has ventral lobe with hastate prongs, divided to about half its overall length by median sinus and having convex sides, slightly pinched in orad; first lateral saddle slightly narrower than ventral lobe, spatulate; first lateral lobe slightly wider and longer than ventral lobe, sides not evenly convex but each with subangulation near middle, acuminate; second lateral saddle rounding asymmetrically and curving very gently to umbilical shoulder; umbilical lobe short, acuminate. Internal suture consists of fairly symmetric short pointed lobes separated by slightly wider, faintly asymmetric saddles; dorsal lobe somewhat hastate; first lateral lobe more strongly hastate, with extended point.

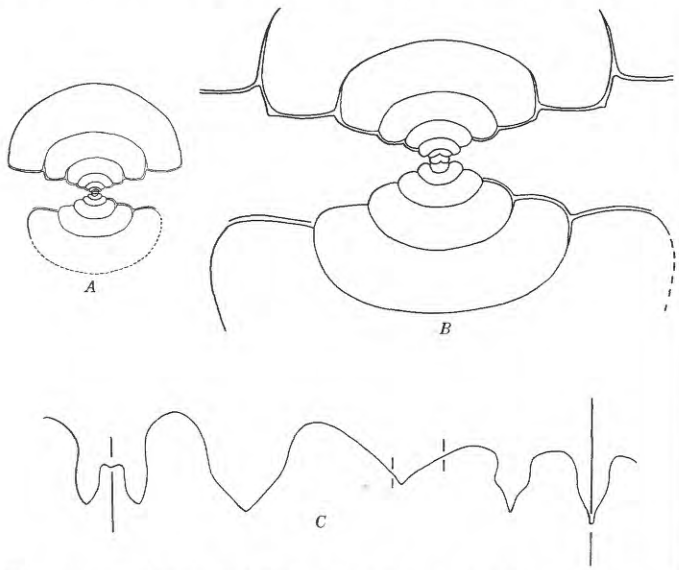


FIGURE 4.—Cross sections and suture of *Syngastrioceras lanei* n. sp. *A*, *B*, cross sections × 1½, × 5 of paratype, USNM 161533 from USGS loc. 23300–PC; *C*, suture × 4 from paratype, USNM 161532, from same locality, where H = 4.7 and W = 10.5 mm.

	USNM specimen						
	161527	161525	161528	161533	161526	161534	161630
Dimensions (mm)							
Diameter (D)	28.5	26.0	19.5	16.0	15.9	14.2	5.6
Height of last whorl (H)	13.0	14.0	10.2	8.0	7.6	6.8	2.3
Width of last whorl (W)	[1]24.5	23.8	18.0	14.1	14.3	12.5	4.7
Width of umbilicus (U)	9.5	7.8	5.5	5.2	4.7	5.3	2.6
Proportions							
U/D	0.33	0.30	0.28	0.32	0.30	0.37	0.47
W/D	.86	.91	.95	.88	.90	.88	.86
W/H	1.88	1.70	1.76	1.76	1.89	1.83	2.04

[1] Partly estimated.

Discussion.—This species is represented by 27 specimens from two localities near Indian Springs, Clark County. It has not been recognized in the Nevada Test Site, although it is associated in the basal Bird Spring Formation in Clark County with the same fauna that occurs in the basal Tippipah Limestone in Nye County.

Syngastrioceras lanei is a small subglobose to globose species having a single cord along the umbilical shoulder like that found in other species assigned to this genus. It differs from *S. globosum* (Easton), from the Hale Formation of northeast Arkansas, by being much more involute and having a first lateral lobe that is almost twice as wide as that of the Hale species.

The suture of *S. lanei* is very much like that of *S. oblatum* (Miller and Moore) at the same conch diameter, but the conch of *S. lanei* is wider and has a distinctly broader and flatter venter than *S. oblatum*. The configuration of the venter is somewhat like that of *S. depressum* Gordon, but that species is very evolute.

Types.—Holotype, USNM 161525; paratypes, USNM 161526–161535, inclusive.

Occurrence.—Bird Spring Formation, 1–3 feet above base, USGS loc. 22465–PC (USNM 161525–161531) and 23300–PC (USNM 161532–161535).

Syngastrioceras oblatum (Miller and Moore)

Figures 5, 6

1896. *Gastrioceras globulosum* (Meek and Worthen) Smith [part], Am. Philos. Soc. Proc., v. 35, no. 152, p. 258–260, pl. 18, figs. 1a–3, 5a–6b [not fig. 4]. Reprinted as Stanford Univ., Hopkins Seaside Lab., Contr. Biology, no. 9, p. 48–50, same pl. and figs.

1903. *Gastrioceras globulosum* (Meek and Worthen) Smith, U.S. Geol. Survey Mon. 42, p. 89, 90 [not pl. 6, fig. 1, pl. 21, figs. 7–9].

1938. *Cravenoceras? morrowense* Miller and Moore [part], Jour. Paleontolgy, v. 12, no. 4, p. 346, 347, pl. 43, fig. 1, text fig. 2B [not pl. 43, figs. 2, 3, text fig. 2A].

1938. *Glaphyrites oblatus* Miller and Moore, Jour. Paleontology, v. 12, no. 4, p. 352, 353, pl. 43, figs. 10, 11, text fig. 3A.
1944. *Cravenoceras*? *morrowense* Miller and Moore. Miller and Owen, Jour. Paleontolgy, v. 18, no. 5, p. 421, 422, pl. 65, figs. 3, 4, pl. 66, figs. 3, 4, text fig. 2B.
1944. *Glaphyrites oblatus* Miller and Moore, Jour. Paleontology, v. 18, no. 5, p. 425–427, pl. 66, figs. 5–13, text fig. 4C.
1962. *Cravenoceras*? *morrowense* Miller and Moore. Unklesbay, Oklahoma Geol. Survey Bull. 96, p. 59, 60, pl. 8, figs. 8, 9, text fig. 4.
1962. *Glaphyrites oblatus* Miller and Moore. Unklesbay, Oklahoma Geol. Survey Bull. 96, p. 87, 88, pl. 13, figs. 1–3, text fig. 6B.
1964 [1965]. *Glaphyrites morrowensis* (Miller and Moore). Gordon [part], U.S. Geol. Survey Prof. Paper 460, p. 223, 224, pl. 23, figs. 13–15, text figs. 59*G*, *H*, 60*C* [not pl. 23, figs. 19, 20, 30, 31, text fig. 60D].
1964 [1965]. *Glaphyrites oblatus* Miller and Moore. Gordon, U.S. Geol. Survey Prof. Paper 460, p. 224, 225, pl. 23, figs. 3–5, 10–12, text figs. 59*A–D*, 60*A*.

A single worn specimen is referred to this species. At the time of the preparation of my report on the Arkansas Carboniferous cephalopods (Gordon, 1964), this specimen was regarded as belonging in *Glaphyrites morrowensis* (Miller and Moore, as interpreted in that report). The types of Miller and Moore's species, which was described as *Cravenoceras*?, were lost at that time and unavailable for study. Later they were found and have been reexamined by J. A. McCaleb in a study of the ammonoids of the Bloyd Shale. According to McCaleb (written commun., 1965), the two syntypes of *Cravenoceras*? *morrowense* figured by Miller and Moore (1938) belong in different genera. One is the species that I described as *Pygmaeoceras solidum* Gordon. The other is an involute form of *Syngastrioceras oblatum* (Miller and Moore). McCaleb intends to designate one of them as the type of *C.*? *morrowense* Miller and Moore. McCaleb and I had independently reached the conclusion that *Glaphyrites oblatus* Miller and Moore should be referred to *Syngastrioceras* and not included in *Glaphyrites*. I further believe that *Syngastrioceras oblatum* (Miller and Moore) may be a junior synonym of *Goniatites nolinensis* Cox, but the holotype of the Kentucky species has been lost and I have not been able to locate a topotype and therefore hesitate to use Cox's name.

FIGURE 5.—*Syngastrioceras oblatum* (Miller and Moore), a unique worn specimen × 1, USNM 161524, from USGS loc. 16315–PC.

The specimen (fig. 5) is a phragmocone, slightly distorted in its coiling, one side of which is badly eroded. The surface of the internal mold is intact in some places; within the narrow umbilicus, the external surface of the umbilical shoulder is marked by a fairly strong cord. A reasonably well preserved external suture (fig. 6) is exposed a little less than one volution from the end. It has the configuration typical of sutures of *S. oblatum* at this diameter.

The dimensions of the specimen (in mm) are as follows: Diameter (D), 53; height of last whorl (H), 22.5; width of last whorl (W), 32, approximately; and width of umbilicus (U), 11. This gives the following proportions: U/D=0.21,W/D=0.60, and W/H=1.42.

Figured specimen.—USNM 161524.

Occurrence.—Bird Spring Formation, basal 75 feet, USGS loc. 16315–PC, Clark County, Nev.

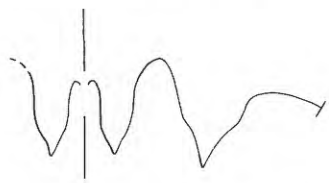


FIGURE 6.—Suture of *Syngastrioceras oblatum* (Miller and Moore). × 1½, where D = 33 (estimated), H = 13, and W = 17 mm. From specimen shown in figure 5.

Genus BISATOCERAS Miller and Owen, 1937

Bisatoceras nevadense n. sp.

Figures 7*A–R*, 8*A–C*

Diagnosis.—*Bisatoceras* with approximately same shell shape as type species but differing in having less sinuous growth striae, narrower lobes in external suture, and a narrow open umbilicus.

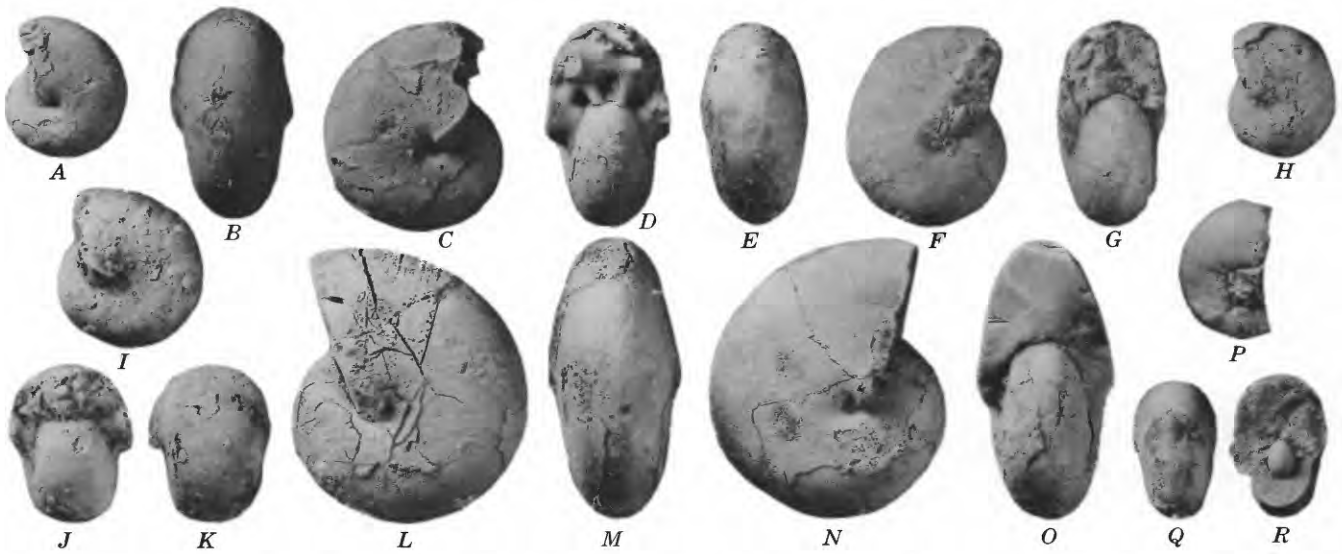


FIGURE 7.—*Bisatoceras nevadense* n. sp. *A–D*, Side view × 1 and back, side, and front views × 1½ of a paratype, USNM 161540 from USGS loc. 23300–PC; *E–H*, back, side, and front views × 1½, and side view × 1 of a paratype, USNM 161546 from USGS 1oc. 20562–PC; *I–K*, side, front, and back views × 3 of immature paratype, USNM 161547 from same locality as *E–H*; *L–O*, side, back, opposite side, and front views × 1 of holotype, USNM 161536 from USGS loc. 22465–PC; *P–R*, side, back, and front views × 2 of paratype showing inner whorl, USNM 161537, from same locality as *L–O*.

Description.—Immature conch thick discoidal, becoming subdiscoidal with maturity, extremely involute; venter rather narrow, rounding evenly into flanks, which are slightly convex to flat and slope gently toward venter. Umblical shoulder broadly rounded; umbilical wall narrowly rounded; umbilicus narrow but open within small shallow funnel-shaped depressed area. Transverse section (fig. 8*A*, *B*) shows first two to three whorls planorbitally coiled, next two widening rapidly to thick discoidal conch with nearly closed umbilicus; very narrow. Shell attains subdiscoidal shape at diameters of 30 mm and greater.

Conch ornamented by gently sinuous transverse growth striae that form moderately shallow sinus over umbilical shoulder, barely perceptible bow and sinus over flanks, deeper orad bow over ventrolateral shoulder, and shallow sinus over venter. Sinuousity less strong in immature stages so that transverse striae appear almost straight across flanks in some specimens. Transverse growth constrictions appear to be limited to no more than one per volution in immature shell.

External suture with very broad ventral lobe and rather narrow first lateral lobe (fig. 8*C*). Ventral lobe with two large prongs having convex sides and pointed tips, divided to a depth equal to about four-fifths of its overall length; first lateral saddle a little narrower than either prong of ventral lobe, rather narrowly rounded orad; first lateral lobe about as wide as first lateral saddle, asymmetrical in that orad side is gently convex and dorsad side both concave and convex, tapering gracefully to moderately sharp point that reaches plane tangent to points of ventral lobe prongs; second lateral saddle shallow, broad, and slightly curved across inner flanks to umbilicus. Umbilical lobe short and broad. Internal suture includes three narrow lobes separated by narrow saddles and connected by wider, shallower saddle to umbilical lobe, but details cannot be observed on these specimens.

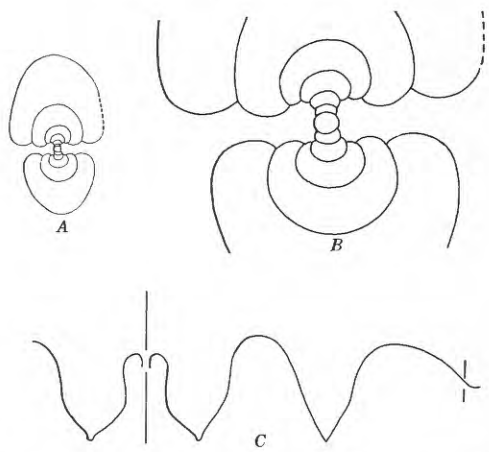


FIGURE 8.—Cross sections and suture of *Bisatoceras nevadense* n. sp. *A*, *B*, Cross sections × 1½, × 5 of paratype, USNM 161541 from USGS loc. 23300–PC; *C*, external suture × 3 from paratype shown in figure 7*A–D*, where D = 17.0, H = 10.0, and W = 10.3 mm.

	USNM specimen						
	161536	161540	161542	161541	161543	161544	161538
Dimensions (mm)							
Diameter (D)	38.3	18.2	17.3	13.2	12.2	5.3	4.8
Height of last whorl (H)	22.7	11.5	10.7	7.8	7.6	3.0	2.9
Width of last whorl (W)	17.4	10.9	11.5	8.0	8.0	3.5	3.3
Width of umbilicus (U)	3.3	1.8	1.7	1.4	1.3	.8	1.2
Proportions							
U/D	0.08	0.10	0.10	0.11	0.11	0.15	0.25
W/D	.43	.60	.63	.61	.66	.66	.69
W/H	.76	.95	1.07	1.03	1.05	1.17	1.13

Discussion.—Included in the type lot are 40 specimens from four collections. The type locally (loc. 3, fig. 1) is 4½ miles southwest of Indian Springs, but specimens from Lane's locality (USGS loc. 23300–PC) just south of Indian Springs (loc. 4, fig. 1) and the C. P. Hills in the Nevada Test Site (loc. 2, fig. 1) have been used in preparing this description.

Bisatoceras nevadense n. sp. has a shape much like that of the type species of the genus, *B. primum* Miller and Owen from beds of Late Pennsylvanian (Missourian) age in Oklahoma. A direct comparison with the topotypes of the Oklahoma species shows, however, that *B. primum* has a slightly narrower venter, slightly less depressed umbilical region, a closed umbilicus, slightly more sinuous transverse striae at the same diameter, and generally more closely spaced septa.

Two other species have been described from rocks of Morrow age, *B. paynei* Gordon and *B.* (*Pseudobisatoceras*) *secundum* Miller and Moore. *B. paynei* has a more tumid shell than *B. nevadense* and transverse sculpture consisting of lamellae that are slightly raised along their orad edge as in *Cravenoceras;* the prongs of its ventral lobe are a little smaller than in *B. nevadense. B.* (*Pseudobisatoceras*) *secundum* differs in having longitudinal lirae on the surface of the conch.

Types.—Holotype, USNM 161536; paratypes, USNM 161537–161548 inclusive, and USNM 161331.

Occurrence.—Bird Spring Formation, 1–3 feet above base, USGS locs. 22465–PC (USNM 161536–161538), 23300–PC (USNM 161539–161548), Clark County; Tippipah Limestone, 1–3 feet above base, USGS loc. 22442–PC (USNM 161331), Nye County, Nev.

Genus DIABOLOCERAS Miller and Furnish, 1940

Diaboloceras peroccidens n. sp.

Figures 9*A–E*, 10*A–F*

Diagnosis.—*Diaboloceras* with early whorls coiled as in *Brannerоceras*, moderately involute for genus. Eight-lobed suture without incipient lobes in umbilical region.

Description. — Conch subdiscoidal, moderately large, the holotype still a phragmocone at diameter (estimated) of 75 mm, moderately evolute, width of umbilicus equal to two-fifths of conch diameter. Venter well-rounded, merging into flanks which are flat or very slightly convex and slope away from venter widening gradually toward umbilical shoulders, which are rounded. Umbilical wall strongly convex; umbilicus gently stepped within. Early whorls depressed (fig. 9*A, B*), planorbitally coiled as in *Brannerоceras*, becoming gradually higher with growth; height and width reach equality in early part of ninth whorl; beyond this, its height exceeds width.

Slightly rursiradiate ribs ornament innermost flanks and umbilical shoulders, dying out about one-third of way across flanks and before middle of umbilical wall; riblets rather sharp on early whorls, becoming broader and gradually weaker on later whorls; on last four whorls of holotype, rib count is 29–27–29–30, ending at outermost point of conch that has venter preserved. Transverse sinuous, minutely wavy lirae are bunched together over ribs so that four to six cover rib and one occupies interspace in adult; single or dichotomous lirae at each riblet in immature whorls; lirae spread out ventrad to form network where crossed by longitudinal lirae on ventral part of whorl. Transverse lirae begin parallel to ribs and form gentle sinus over inner flank, swing forward to form adoral bow over ventrolateral zone and a deeper rounded sinus over venter. Longitudinal lirae are strongest over venter and die out approximately at midflank, approximately 30 occurring on holotype between midflank and midventer; evenly spaced microscopic sculpture of transverse lirae on inner flank suggests continuation of longitudinal lineation; fairly sharp subtriagular nodes pointing orad occur at intersection of transverse and longitudinal lirae, particularly in ventral region.

Suture in adult shell includes in external part ventral and two pairs of lateral lobes, shown for holotype (fig. 10*D*) at diameter of 52 mm and slightly crushed paratype (fig. 10*C*) at diameter (estimated) of 65 mm. Ventral lobe wide, having two stout prongs with long points tilted slightly apart apicad, divided to a depth equal to about four-fifths of its overall length by median sinus shaped like inverted goblet. First lateral saddle about as wide as one prong of ventral lobe, very slightly asymmetric, broadly rounded orad. First lateral lobe slightly narrower than first lateral saddle, asymmetric, ventrad side gently convex throughout and dor-

sad side convex becoming concave toward point. Second lateral saddle rather narrowly rounded orad but spreading rather rapidly apicad. Second lateral lobe with point located just outside of umbilical shoulder, having ventral side sigmoidal and dorsad side concave. Suture slopes diagonally across umbilical wall without forming incipient lobes.

Internal suture (fig. 10*C*) consists of narrow symmetrical hastate dorsal lobe separated by narrow saddles from pair of narrow, asymmetric first lateral lobes, slightly shorter than dorsal lobe. Shallow, slightly asymmetric saddles extend to edge of umbilical wall.

Suture in young phragmocone (fig. 10*F*) at approximate diameter (estimated) of 9 mm shows practically none of characteristic configuration of more mature sutures. Lobes are narrow and narrowly rounded apicad. However, immature suture in *Branneroceras* stage (fig. 10*E*) at diameter of roughly 20 mm shows some semblance of asymmetric pointed lobes of adult.

	USNM specimen			
	161550	161551	161558	161553
Dimensions (mm)				
Diameter (D)	59.7	29.7	13.3	12.2
Height of last whorl (H)	23.2	9.8	3.0	3.5
Width of last whorl (W)	20.8	11.3	[1]4.0	3.5
Width of umbilicus (U)	24.0	13.5	8.3	7.5
Proportions				
U/D	0.40	0.45	0.63	0.61
W/D	.35	.38	.30	.41
W/H	.90	1.15	1.33	1.43

[1] Twice the half width.

Discussion.—Contributing to the description of this species are 19 specimens from six localities in Nye and Clark Counties, Nev. The suture of *Diaboloceras peroccidens* n. sp. lacks the incipient lobes on the umbilical wall that are found in the type species of the genus *D. varicostatum* Miller and Furnish. The nearest American species is *D. neumeieri* Quinn and Carr, which has a similar suture but broader whorls, a more evolute conch, and a strong tendency for the early whorls to be triangular in their coiling; this tendency is not found in *D. peroccidens*. Probably this western species is closest to *D. ruzhencevi* Andrianov from the Bashkirian Stage in the lower reaches of the Lena River in the Verkhoyansk region, U.S.S.R. The Siberian species is, however, more evolute than *D. peroccidens;* the width of the umbilicus in a specimen with a diameter of 50 mm is equal to slightly more than five-eighths the diameter of the conch. The suture of *D. ruzhencevi* has a much narrower ventral lobe than *D. peroccidens,* each prong of which is considerably narrower than the first lateral lobe.

The evolutionary stage of development reached by *Diaboloceras peroccidens* n. sp. is intermediate between that of *Branneroceras branneri* (Smith) of early Bloyd (early late Morrow) age and *Diaboloceras neumeieri* Quinn and Carr of late Bloyd age. It already had gone beyond the *Branneroceras* stage of development and acquired a *Diaboloceras* suture by the migration of the umbilical lobe onto the inner flanks to become a second lateral lobe, but its early whorls resemble those of *Branneroceras*, not yet

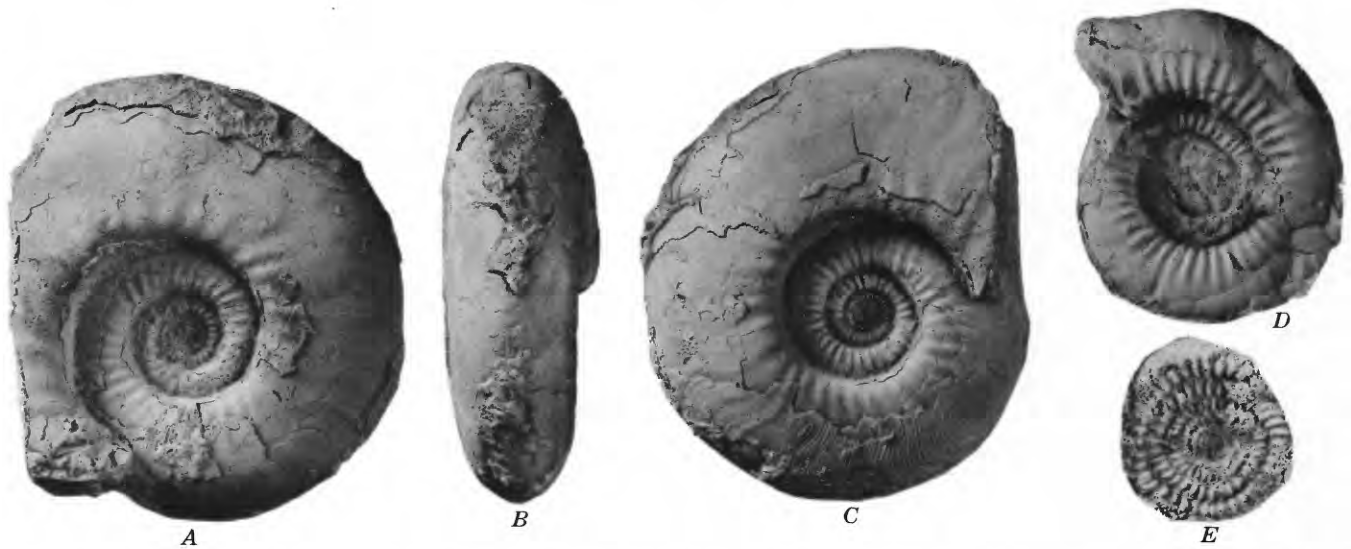


FIGURE 9.—*Diaboloceras peroccidens* n. sp. *A–C*, Side, back, and opposite side views × 1 of holotype, USNM 161550 from USGS loc. 23300–PC; *D*, side view × 1 of partly crushed paratype, USNM 161560 from USGS loc. 22442–PC; *E*, latex cast of external mold of early whorls × 3 of a paratype, USNM 161555 from USGS loc. 22465–PC.

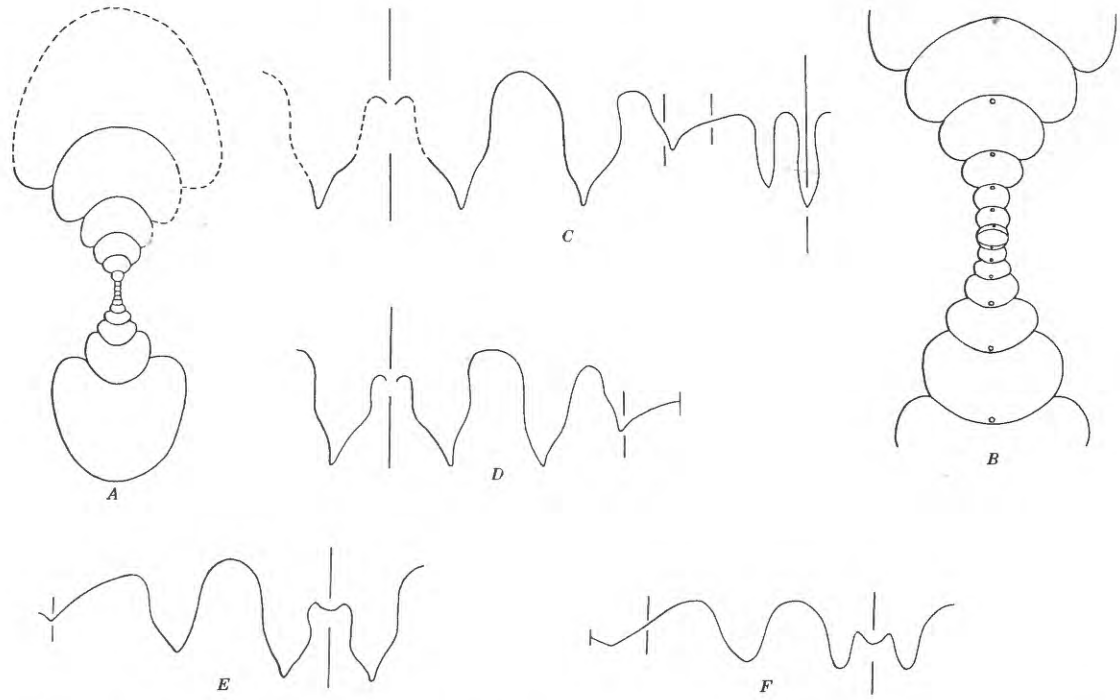


FIGURE 10.—Cross sections and sutures of *Diaboloceras peroccidens* n. sp. *A*, *B*, Cross sections × 1½, × 5 of a paratype, USNM 161661 from USGS loc. 23300–PC; *C*, suture × 1½ of a paratype, USNM 161552 from same locality as *A*, where H = 24 mm (approximately); *D*, external suture × 1½ of holotype, USNM 161550, from same locality as *A*, where H = 18.7 and W = 17.2 mm; *E*, *F*, external sutures of two immature paratypes from USGS loc. 22465–PC, USNM 161557 × 6, where H = 4.2 and W = 5.6 mm, and USNM 161556 × 8, where H = 2.4 and W = 3.6 mm.

having acquired the strong tendency toward triangular coiling shown by later species of *Diaboloceras*. This intermediate stage is presumably intermediate in time and can be assumed to have been reached toward the middle of Bloyd time.

Types.—Holotype, USNM 161550; paratypes, USNM 161551–161562 inclusive.

Occurrence.—Bird Spring Formation 1–3 feet above base, USGS locs. 22465–PC (USNM 161555–161559), 23300–PC (USNM 161550–161554), Clark County; Tippipah Limestone, lower part, USGS locs. 19668–PC (USNM 161561), 20559–PC (USNM 161562), 22435–PC, and 22442–PC (USNM 161560), Nye County, Nev.

Genus STENOPRONORITES Schindewolf, 1934

Stenopronorites sp.

Figures 11*A*–*E*, 12

This record is based upon three immature specimens, each from a different locality. Two of them are figured (fig. 11) and show the discoidal shape and planorbital coiling in the early stages of this species. In the largest specimen the whorl is beginning to increase in height, but the height is still less than the width. The venter and flanks are gently convex and the ventrolateral and dorsolateral zones strongly convex. Growth lines, preserved in two moderately large patches of surface sculpture, form a broad convex bow orad across each dorsolateral zone and flank and a shallower orad bow over the venter, the two bows separated by a rather narrow shallow sinus over each ventrolateral zone.

The suture (fig. 12) at a diameter of a little less than 12 mm is in the *Pronorites* stage. It consists of a trifid ventral lobe, a simple bifid first lateral lobe, two narrow slightly asymmetric lateral lobes and a rounded umbilical lobe, the last three lobes of

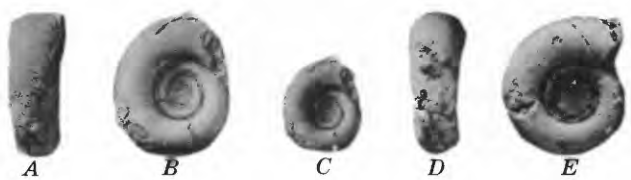


FIGURE 11.—*Stenopronorites* sp. *A*–*C*, Back and side views × 1½ and side view × 1 of specimen USNM 161548, from USGS loc. 23300–PC; *D*, *E*, back and side views × 2 of specimen USNM 161549, from USGS loc. 22465–PC.

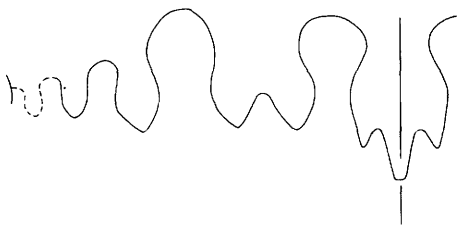


FIGURE 12.—External suture of *Stenopronorites* sp. × 5 from specimen shown in figure 11*A–C*, where D = 11.7, H = 4.0, and W = 4.8 mm.

gradually diminishing lengths. The intervening saddles are rounded.

	USNM specimen		
	161548	161549	161332
Dimensions (mm)			
Diameter (D)	12.0	9.0	5.3
Height of last whorl (H)	3.8	2.9	1.6
Width of last whorl (W)	5.0	3.3	2.0
Width of umbilicus (U)	6.7	5.0	3.1
Proportions			
U/D	0.56	0.56	0.58
W/D	.42	.37	.38
W/H	1.31	1.17	1.25

Discussion.—The first of these specimens to be found was the smallest and came from the C. P. Hills. A little over 5 mm in diameter, it consists of only three whorls, the suture limited to the first two. It was tentatively identified as *Boesites*? in Poole, Orkild, Gordon, and Duncan (1965, p. A52). The later finding of two specimens from Clark County permitted the recognition of this species as a pronoritid.

Although no specimens from the *Diaboloceras peroccidens* Zone show the adult characters of *Stenopronorites*, the fact that these immature shells are already in the *Pronorites* stage of development and that adult *Pronorites* has not been found above the Mississippian renders the reference to *Stenopronorites* reasonably certain.

Figured and measured specimens. — USNM 161332, 161548, and 161549.

Occurrence.—Tippipah Limestone, lower 20 feet, USGS loc. 22071–PC (USNM 161332), Nye County; Bird Spring Formation, 1–3 feet above base, USGS loc. 22465–PC (USNM 161549), 23300–PC (USNM 161548), Clark County, Nev.

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